

**REINFORCING TAPE COMPRISING A PLY OF LONGITUDINAL
HIGH-TENACITY YARNS**

Field of the invention

5 The invention relates to the field of high-performance
textiles, and more precisely to textile reinforcements
used as reinforcing elements. It relates more
particularly to a novel structure of reinforcing tape
produced from high-tenacity yarns that are used in
10 order to be wound around various structures for the
purpose of reinforcing them.

The aim of the invention is to improve this type of
tape so as to be able to preserve almost all of the
15 tenacity properties of these tapes when they are
subjected to high stresses, both mechanical stresses
and those from the standpoint of the environmental
conditions.

20 **Prior art**

In general, very many structures have to be reinforced
since they are the seat of particularly high mechanical
stresses. As an example, mention may be made of
flexible pipes used in the field of oil drilling, which
25 have to withstand particularly high pressures when they
are conducting pressurized gases. The stresses are not
only mechanical, but also thermal and chemical since
the materials employed must be inert vis-à-vis the
gases being transported and must not be degraded when
30 they are used in an aqueous and/or saline medium. This
is why the pipes used include textile reinforcements in
the form of tapes wound in a helix around the central
portion of the pipe. To ensure that the pipe is well
able to withstand the internal pressure within the
35 pipe, it is known to use tapes based on high-tenacity
yarns, and especially aramid-based yarns, glass fibers
or carbon fibers.

Such a tape may in particular be produced using the teachings of the Applicant's document EP 0 193 478. This is because such a tape comprises longitudinal aramid yarns bound together by loosely woven weft yarns in such a way that the aramid yarns have the least possible shrinkage and are therefore flat in order to maintain their mechanical properties.

Various problems arise with the tapes produced from these high-tenacity fibers and especially degradation in the mechanical properties of the tape due to the contact of this tape with the elements that surround it. Thus, several different tapes are often used, which are wound around one another, generally in different directions. In this case, the aramid, glass or carbon yarns come into contact with one another and therefore rub against one another, especially when the pipe is flexible, since the various superposed layers have a tendency to slide over one another. This may result in the degradation of the mechanical properties of some of the yarns, with the appearance therefore of areas of weakness that may completely prejudice the integrity of the pipe.

The longitudinal aramid, glass or carbon yarns may also come into abrasive contact with the other reinforcing elements that are used in a complementary manner. It will of course be appreciated that the use of the metal reinforcements, or more generally the use of a material of high hardness, may cut certain fibers, thereby reducing, at least locally, the overall toughness of the tape. Furthermore, it may turn out that the reinforcing tapes are covered with impermeabilizing materials, such as resins or other rubbery materials that are cured *in situ*. In this case, such materials at least partly penetrate inside the fibers and, after curing, preclude the possibility of the fibers of any one yarn sliding relative to the others. This results in the stiffening of the tape, which limits the

flexibility of the pipe and may even degrade the tenacity properties of the longitudinal yarns.

5 This drawback is observed in particular in tapes that have undergone a step in which they are coated with a thermoplastic for the purpose of protecting them from external attack.

10 Moreover, it is known that aramid fibers are very sensitive to ultraviolet radiation. This is because prolonged exposure of the aramid yarns to sunshine results in degradation of the chemical structure of the aramid fibers, which results not only in a change in their color but above all in their mechanical strength
15 properties being degraded. This is why, when they are being transported, spools of aramid tape are generally protected by opaque packaging. However, this protection is effective only while the tape is inside the packaging, and as soon as the tape is employed, to be
20 wound around the pipe or more generally its support, it is exposed to attack by ultraviolet radiation. In other words, the protection afforded by the opaque packing is not completely satisfactory since it does not guarantee protection from ultraviolet right up to when the tape
25 is installed in the final application.

Furthermore, it may happen that the final application of the reinforcing tape means that the latter remains exposed to ultraviolet radiation, and therefore its
30 properties will degrade after it has been installed. Mention may especially be made of the use of this tape as a reinforcing element for civil engineering works, and especially bridge piles. In this case, the tape is almost immersed in water which is also known to degrade
35 the mechanical properties of the aramid.

The problem that the invention aims to solve is that of preserving the mechanical properties of reinforcing tapes based on longitudinal high-tenacity yarns, and to

do so despite being exposed to the external environment, especially moisture or ultraviolet radiation. Another problem is that of protecting this tape from the various abrasive contacts when the tape
5 is being installed.

Summary of the invention

The invention therefore relates to a reinforcing tape that includes, in a known manner, a ply of
10 longitudinal, aramid-, glass- or carbon-based high-tenacity yarns bound together by weft yarns.

According to the invention, this tape is characterized in that it also includes two thermoplastic films, each
15 placed on one side of the ply of longitudinal yarns.

Put another way, the invention consists in covering both sides of the ply of longitudinal yarns with a layer of thermoplastic, which does not penetrate into
20 the ply, and therefore lets the inner fibers of the yarns have a freedom of movement. These thermoplastic films therefore provide mechanical protection for the yarns from external contacts, and without binding the fibers together, thereby leaving the tape the ability
25 of undergoing sufficient deformation in order to be able to be configured according to the geometry of the article to be reinforced, and maintaining high mechanical properties. These thermoplastic films are therefore interposed between the plies of yarns of
30 different tapes when these are superposed, therefore preventing direct contact between the yarns and therefore preserving them from a certain amount of abrasion.

35 In practice, the thermoplastic films may adhere slightly to that side of the ply which they cover, in such a way that they then have the same width as that of the ply.

In an alternative embodiment, the two thermoplastic films may be bonded together along the edges of the tape, and therefore in this way imprison the ply of yarns. These films may result either from two separate
5 sheets welded together along the two edges of the tape, or else from a single sheet folded over itself, being welded along only one edge of the tape.

Advantageously in practice, the ply of longitudinal
10 yarns may be capable of sliding within the sheath formed by the two films. In other words, the ply of yarns has a certain degree of freedom relative to the films that do not adhere to the ply, but on the contrary allow it to move slightly. This freedom of
15 movement of the ply allows the latter to move when the movement is configured or wound onto its application, in such a way that the stresses on the high-tenacity yarns are relatively distributed, which is conducive to mechanical properties being maintained.

20 In a preferred form, applied in the aramid case, to the films has ultraviolet radiation blocking properties so that the aramid yarns of the tape are protected from external radiation and therefore retain their initial
25 mechanical properties. Thus, the aramid fibers are protected as soon as the tape has been produced, by placing it in characteristic films, right up to the end use on the article to be reinforced.

30 Advantageously in practice, the longitudinal yarns may be bound together by at least partly thermoplastic weft yarns. These weft yarns may either be based on a thermoplastic or may be yarns having a core and coatings of a thermoplastic. It is also possible to use
35 weft schemes comprising one or more weft yarns per step.

Thus, it may be advantageous to use, both for the weft yarns and for the films covering the ply,

thermoplastics having similar properties, especially as regards softening temperatures, so that, when installing the characteristic films, a heating operation is carried out which reveals the thermoplastic properties of the weft yarns, thus anchoring the films on the weft yarns.

In practice, in order to provide protection from moisture, it is also possible to use microporous films that have breathing properties, and therefore allowing a moisture present inside the external sheath formed by the film to be removed.

Brief description of the figures

The manner in which the invention is realized, and the advantages that stem therefrom, will become clearly apparent from the description of the embodiments that follow, supported by the appended figures, in which:

- figure 1 is a top view of a tape according to the invention, in which a portion of one of the characteristic films has been removed;

- figure 2 is a cross-sectional view of the tape shown in figure 1; and

- figures 3 and 4 are sectional views of alternative embodiments.

Manner of realizing the invention

The tape (1) illustrated in figure 1 comprises a ply (2) of aramid yarns (3) woven loosely with weft yarns (4). This ply (2) receives, on each of its sides, a thermoplastic film (5, 6).

In the embodiment illustrated in figure 1, the two films (5, 6) are wider than the ply of yarns (3) and extend laterally therefrom in regions in which they face each other where they will be welded together. These welding regions therefore form the edges (8) of the tape.

In this way, the sheath formed by the two films (5, 6) allows the ply (2) of yarn to move slightly and facilitates its deformation when this tape is used on supports that are not flat.

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Figure 3 illustrates an alternative embodiment in which the sheath is formed by a single film (19) folded over on itself in order to form the edge (11), which sheath is welded to itself in the region (12) corresponding to the edges of the sheet forming the film (10).

The invention also covers the embodiment illustrated in figure 4, in which the ply (2) of aramid yarns receives two separate films (15, 16), each on one side of the ply (2). In this case, the two films (15, 16) adhere slightly to the ply of aramid yarns, after they have been exposed to a heat source.

In practice, the yarns (3) of the ply (2) are aramid-based and therefore may in particular be chosen from the products sold under the brand name KEVLAR® by DuPont or TWARON® by Teijin. Each yarn may preferably be a multi-end cabled yarn, of unitary linear density between 1670 dtex and 3300 dtex, depending on the function of the applications. The yarn may also receive a twist in the S and Z directions of about 60 turns/meter. Of course, the number of ends, and the linear density of each end and their twist, may be adapted according to the desired application.

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In practice, good results are obtained when using plies whose yarns, possibly multi-filament yarns, are numerous, about ten per centimeter and over a width that may range from about five to twenty centimeters.

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As already mentioned, the ply (2) of aramid yarns is woven loosely, that is to say in such a way that the warp yarns are as flat as possible, and therefore have a particularly low shrinkage. This type of weaving,

also called "high-modulus weaving", therefore means that the shrinkage of the weft yarns is relatively high. The weft yarns are therefore relatively spaced apart, typically by around one to three
5 yarns/centimeter approximately.

The yarn employed to form the weft (4) preferably has thermoplastic properties. It may, for example, be a polyester yarn, typically with a linear density from
10 4.9 to 110 tex. It may also be a yarn having a core, which is not thermoplastic, for example based on glass fibers with a linear density of 5.5 to 68 tex, having a sheath, which is thermoplastic, for example based on polyamide.

15 Good results have been obtained by using polyester based films (5, 6) having a thickness of around 20 to 50 microns. This polyester film has the advantage of being thermoplastic, but the invention also covers
20 other variants in which the film has specific properties. For example, it is possible to use multilayer complex films having, for example, a coating with a low friction coefficient, such as a polytetrafluoroethylene coating. It is also possible to
25 use films possessing breathable properties, chosen to allow water vapor to pass from inside the sheath to the outside, while preventing water from penetrating into the sheath when the latter is immersed. It is also possible to use films having fillers that make the film
30 opaque to certain types of radiation, especially ultraviolet radiation, the latter being known to cause degradation of the mechanical properties of the aramid.

In practice, the tapes thus obtained have a strength of
35 the order of a few tens of kN/cm of width, the useful width being measured only on the ply of aramid yarns.

In practice, the tape according to the invention may be obtained by installing the characteristic films on a

ply of aramid yarns, however, it will generally be preferable for the characteristic films to be installed directly after the weaving operations. Thus, as the ply (2) comes off the loom, it receives, on its top and bottom sides, the plastic films (5) and (6) which may be heated differently, and especially by exposure to radiation from a heat source. This heating raises the temperature of the films (5, 6) and a very slight melting of their surface in contact with the aramid ply (2) therefore causes adhesion.

This exposure to a heat source not only causes slight melting of the characteristic films, but also that of the weft yarns (4) that link the aramid yarns (3). These weft yarns thus adhere to the aramid yarns, thereby improving the integrity of the ply, although the number of weft yarns is particularly small.

This operating method is used in particular to produce the tape illustrated in figure 4. The combination of ply (4) and films (15, 16) may then be subjected to a slight pressure, making the adhesion uniform. This pressure may be obtained by calendering, but it may also result from the intrinsic pressure when winding the tape on a mandrel.

To produce the tape (1) shown in figures 1 and 2, the films (5) and (6) are also placed above and below the ply (4) of yarns, and optionally heated. They then receive, by heated rollers located along their edge, the amount of heat for producing the welded region (7).

Of course, the invention is not limited to merely the embodiments illustrated in the figures and specified by numerical values, rather they may cover many alternative embodiments chosen according to the applications, especially when the high-tenacity yarns are glass or carbon yarns.

It is apparent from the foregoing that the tape according to the invention has many advantages, especially that of allowing the aramid yarns to be protected from ultraviolet radiation and from other external factors, especially moisture. It also provides mechanical protection of the high-tenacity fibers from the abrasion generated by contact with other mechanical elements, and especially with the tape itself when the latter is wound. This protection is provided without degrading the mechanical properties of the yarns employed.